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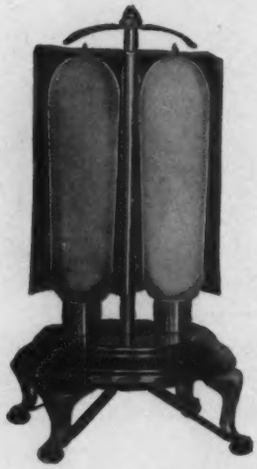

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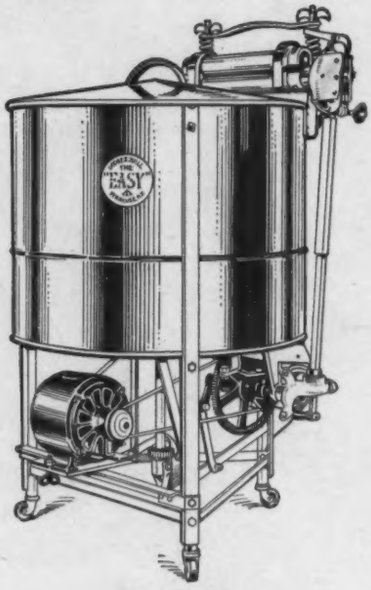

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ELECTRIC STIMULATION OF PLANT GROWTH

BY W. D. PEASLEE.

(This analysis of the effect of electric stimulation of plant growth as observed from experiments with several methods, has resulted in data of interest and importance. The author hopes that those more advantageously equipped for this work will make further investigations along this line.—The Editors.)

It is a well known economic principle that the stability of a country is largely dependent on the ability of the soil to support the population, or in other words, upon its agricultural productivity. The increasing tendency towards the application of scientific methods to all agricultural work, and the establishment of agricultural colleges and departments of agriculture in the large universities is a movement in recognition of this principle. Intensive cultivation is one of the most fruitful methods of increasing the unit agricultural output of the soil.

Early in 1910 the writer took up the study of stimulation of plant growth and was soon led to an investigation of electrical methods as a solution of this problem. In offering here some of the results of the experiments that have been carried on since then, and the theory developed from a study of these and other results, it is hoped that the data presented may be of interest to many and of some value to those who are working along the same lines.

Comparative Illustrations of Stimulated and Unstimulated Plant Growth

Fig. 2. (Beets).
Print of two average plants, 21 days after planting. Current, direct, .00082 amp./sq. in.; 1.06 watts per cu. ft.; 507 watthours per cu. ft.; increase in size, average of 100 plants, 10 per cent.

Fig. 3. (Cauliflower).
Print of two average plants, 17 days after planting. Current, direct, .00009 amp./sq. in; .03 watts per cu. ft.; 10.08 watthours per cu. ft. Increase in size, average 50 plants, 29 per cent. Fertility; electrified 87.7 per cent; non-electrified 65.3 per cent.

Fig. 4. (Cabbage).
Print of two average cabbage plants, 17 days after planting. Current, direct, .00011 amp./sq. in.; .036 watts per cu. ft.; 12.2 watthours per cu. ft.; increase in size, average 100 plants, 52.9 per cent. Fertility; electrified 93.3 per cent.; non-electrified, 58.3 per cent.

Experiments were first undertaken to establish the result of a current passing through the soil containing the seeds or roots of plants. This procedure was on the theory that any results that might be obtained would be due to an enrichment of the soil in the nitrogenous compounds necessary to plant life, by the

chemical action of the current. Many tests were made, most of them at first failures, with various current densities. The two principal causes of failure were too high current densities and the use of electrodes that, decomposing electrolitically, filled the soil with salts injurious to plant life. Carbon was finally adopted as the best electrode material.

Seeds were planted in boxes containing earth from the same mixer and were kept under identical conditions as to temperature, water applied, etc., except that some were subjected to the influence of

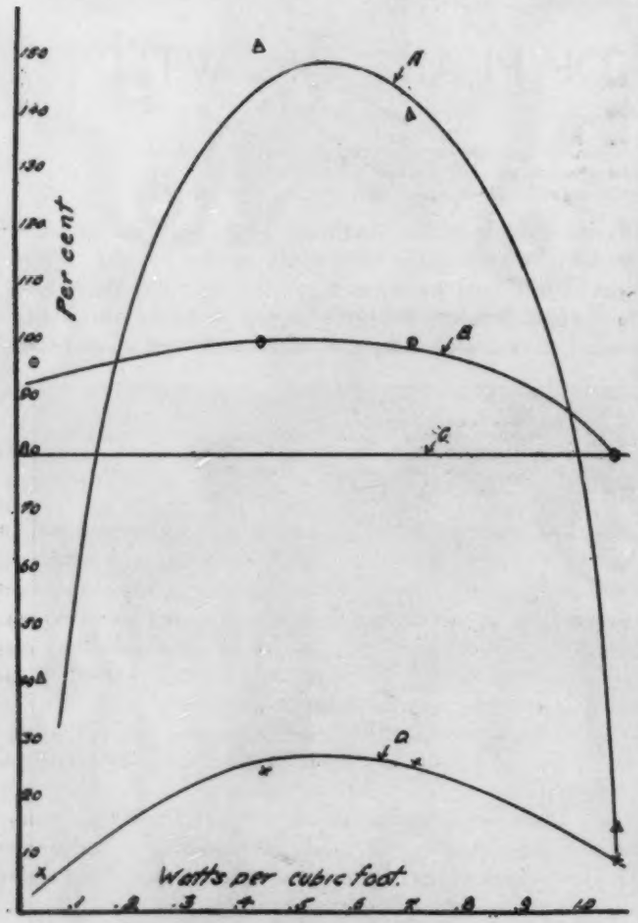

Fig. 1. (Cauliflower).

(A) Size of electrified plants in per cent of size of non-electrified when the latter are ready for transplanting.
(B) Fertility in per cent of electrified seeds.
(C) Fertility in per cent of non-electrified seeds.
(D) Length of time taken by ordinary plant to attain a size suitable for transplanting over time taken by electrified plant.

direct electric currents through the soil while others, used for comparison, were allowed to grow in the usual way. These tests were carried on in a greenhouse and were continued until the non-electrified plants were ready for transplanting to the greenhouse beds. The number of seeds planted in each box were carefully noted as well as the number sprouting to discover any effect the treatment might have on the fertility of the seeds. At the end of each test careful measurements of each plant were made and the results averaged. The data from all the tests has been averaged and studied for principles that might be indicated. Fig. 1 shows a set of curves derived from a great many tests on cauliflower. It should be mentioned here that the curves for other plants such as cabbage or beets, while quantitatively different, have the same typical shape.

When the tests were concluded average plants were pressed and preserved and prints taken of them. Typical specimens are shown Figs. 2, 3 and 4. In these it will be noted that the principal gain is in the root structure, a very desirable end in plants that are to be transplanted. On this account the improvement of the electrified plants was greater than indicated by the percentages shown. It was also noted that the electrified plants, after transplanting, were more hardy and grew faster than the non-electrified, with no further stimulation for either.

Fig. 5 is a photograph of radishes wherein the test was continued until the electrified plants were of a marketable size, the twelve largest plants from the non-electrified bed and the twelve average from the

Fig. 5. (Radishes).
Current, .00014 amp./sq. in., direct; .444 watts per cu. ft.; watthours per cu. ft. 192. Fertility: electrified, 100 per cent; non-electrified, 92 per cent.

electrified bed. None of the non-electrified plants were of marketable size while all the electrified plants were. One was 1½ in. in diameter, and of fine flavor, not, as might be expected, pithy or strong. After the photograph was taken the tops were cut off and weighed, the results being as follows:

Electrified	6.75 oz.
Non-electrified	3.1 oz.
Gain electrified	3.65 oz. or 117 per cent

The roots were then washed and weighed.

Electrified averaged for 25 plants	0.468 oz. each
Non-electrified averaged for 23 plants	0.098 oz. each

This is a gain of 403 per cent in the average size of the edible portion of the plant.

As the test was not continued till the non-electrified plants were of marketable size no results as to the time saved can be given for this test but other tests carried out for that purpose indicate that the excess time taken by the non-electrified plants over the electrified at this value of watts per cubic foot is about 34 per cent.

The prints and photographs shown are selected from a great many tests and are not the best that were obtained but are, as nearly as could be selected, average results under the conditions shown.

Similar tests were made with alternating current 60 cycles and the results were at first rather startling as they were consistently negative. It was finally found that they were positive at very low values of watts per cu. ft. The results of one test on cabbage plants being:

Current .....0.000034 amp. per sq. in.
Power .....0.0114 watts per cu. ft.

Increase in size electrified over non-electrified (average of 40 plants) was 32 per cent.

Fertility electrified—91.3 per cent.
Fertility non-electrified—69.4 per cent.

A comparison of these results with Fig. 4 will show the effect mentioned.

Later, experiments were begun to ascertain the effect of applying a voltage stress to the atmosphere around the plants. After germination the plants were subjected to a constant charge of about 100,000 volts as indicated by a needle gap, with the wires 10 in. from the soil, giving about 10,000 volts per inch stress in the air around the plants. A Wimshurst machine was used to maintain this pressure and tests were made using both positive and negative as the ground to see if any difference in effect could be observed. At first the results, as far as the plants were concerned, were disastrous. It was then found that by applying the pressure only on cloudy days and at night good results could be secured. Finally, after a better understanding of the principles involved was attained, some very remarkable results were secured.

An average of five tests on strawberries showed an increase in size of the electrified over the non-electrified of 27 per cent. Beets showed an increase in size of 14 per cent in the roots and 39 per cent in the tops.

Many tests have been made at different pressures per inch but it seems at present impossible to establish any direct relation between the gain in size of the treated plants and the pressure per inch that is applied. Two points were established, however, that are of great value.

First, no difference in stimulative effect was found when using positive or negative as the ground. This is very gratifying in view of the conflicting results of Lemstrom and Sir Oliver Lodge. The former found that with the ground negative, increased growth was obtained and that a positive ground was harmful to the plants, while the latter found increased growth with either connection. However, the published results of these investigations are very meager, so we are unable to have the privilege of a close analysis of their results. This fact is of great value as it points at once to the use of alternating pressures and permits the employment of a transformer to give the high pressures necessary rather than the erratic influence machine.

Second, there is some tendency to show for all plants a curve approximating a straight line within certain limits, Fig. 6. The slope of this curve is different for each plant and might well be called the "susceptibility factor" of the plant. There is not yet sufficient data at hand to make it possible to more than show the general shape of this curve. This will be readily appreciated when it is remembered that any change in time of an application of the pressure, humidity, etc., will change the results secured and the greatest care is necessary in analyzing the results of different tests. It seems that the best time of application is on cloudy days and at night. Climatic differences will therefore render the results of two otherwise identical tests, very different. It will be seen that a great deal of data is necessary and the greatest care in analyzing it or conclusions will be drawn that may prove confusing.

Tests were then carried on using a Tesla coil outfit in place of the Wimshurst machine and while considerable data has been secured it has not been possible so far to establish anything more than the qualitative fact that an increase in size within about the same limits as with the Wimshurst machine is obtained.

The theory at first held was that the effect shown was due entirely to a chemical action of the current

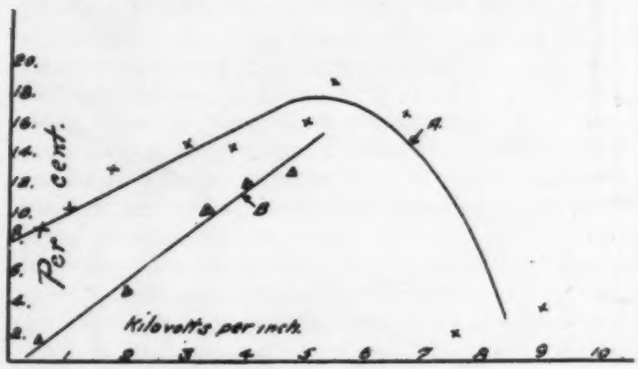

Fig. 6.
(A) Increase in size of electrified over non-electrified plants under stimulus of electrostatically stressed atmosphere. Beets.
(B) Same as A except for Cauliflower.

in increasing the nitrogenous content of the soil, or in the case of atmospheric stress, the driving of nitrogen from the air into the ground. This theory was soon abandoned as, while the effects mentioned were experimentally established, the amount of nitrogen that can be added to the soil in this way is not sufficient to bring about the results secured.

A study of plant life, especially from a psychological point of view was then begun. For information on this subject very grateful recognition is given Mr. J. C. Bose of Calcutta whose work, "Plant Response as a Means of Physiological Investigation," furnished the information that led to the clearing up of the most perplexing points brought out by the tests.

Mr. Bose established by long experiment two laws of plant growth:

1. Direct application of a stimulus, inducing contraction, retards growth.

2. The effect of indirect stimulation is to increase the internal energy and thereby augment the growth.

This indirect stimulation may be:

(a) Stimulation of the root tip: 1, mechanically; 2, electrically, 3, chemically.

(b) Direct stimulation of a distant point, thus causing a wave of positive turgidity variation to be transmitted to the responding organ, if the stimulated point is at a sufficient distance from the disturbance to prevent the effect of the direct stimulation reaching the growing organ, since the effect of a direct stimulation of a growing organ is to induce a negative turgidity variation with a concommittant retardation of growth.

However the energy absorbed from an external direct stimulus may, as an after effect, increase the internal energy of the plant resulting in an accelera-

tion of growth after the removal of the stimulus. This is the indirect effect of direct stimulus and the action of sunlight is a good example. The direct action of sunlight is to reduce the growth rate but after this direct stimulus is removed the rate of growth increases. Fig. 7. This is a curve taken from the above mentioned work of Mr. Bose and shows this after effect very markedly. The growth rate is decreasing while the plant is subject to the direct stimulus of sunlight,

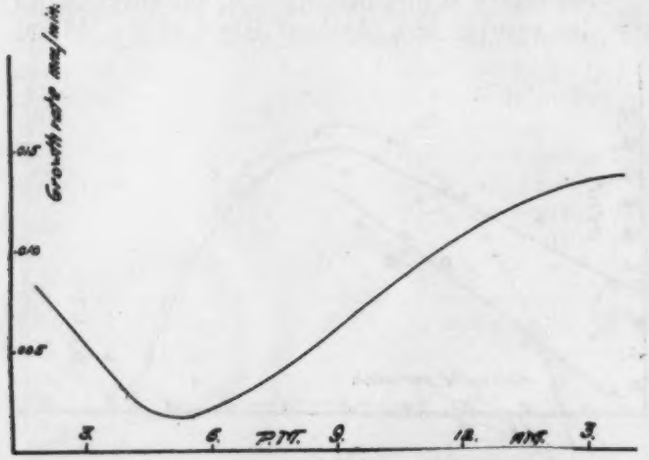

Fig. 7. Effect of direct light stimulation on rate of growth.

and as soon as this direct stimulus is removed the internal energy thus stored accelerates the growth during the early hours of the night, the growth rate falling off towards morning as the stored energy is exhausted.

The effect of a change of temperature might at first be taken for a response to stimulus but Mr. Bose has shown in a striking manner that it is what he calls the "Optimum Effect," i. e. a change in the excitability, which is at its maximum at a definite point for each plant. For tropical plants this point may be determined very closely as indicated by Fig. 8, which is a growth rate temperature curve of a cirnum lily subject to the same stimulus at different temperatures, A plant of the temperate regions would have a much flatter curve and would break gradually at the optimum point rather than in the abrupt manner shown.

Mr. Bose also found that a transverse electric current will excite the root tips with a consequent increase of growth rate, but the currents must be small or the excitation will induce fatigue. This fatigue effect was found very marked and an examination of Fig. 1 will confirm this statement further.

Another effect of currents in the soil is that a plate source of current is a direct stimulation of a distant point and this causes a wave of positive turgidity variation to be transmitted to the roots increasing their functional activity. In other words, it is a direct stimulation of a distant point.

Hertzian waves, as light, are a direct stimulus and retarded growth as would be expected, but the after effect is to increase growth rate.

From the results of Bose's work and the tests herein described the following principles have been established.

1. The direct stimulation of a distant point, i. e. the indirect stimulation of the root or plant induces a wave of positive turgidity variation and thus increases the functional activity of the organs if they are far enough from the point of application of the stimulus to avoid the effect of direct stimulation.

2. Though the immediate effect of direct stimulation is to cause a negative turgidity variation and retard growth it increases the internal energy of the plant and the after effect is to increase the growth rate.

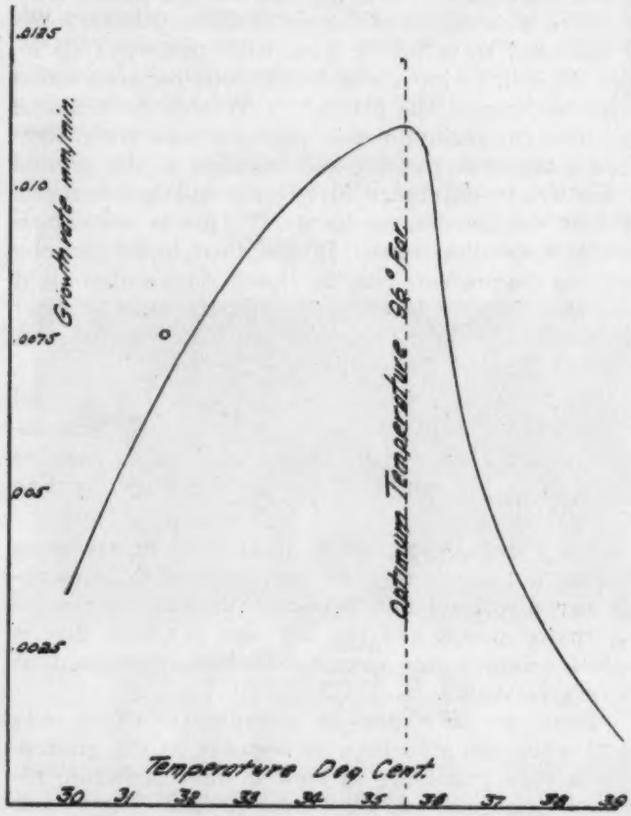

Fig. 8. Effect of temperature on excitability of Cirnum Lily.

3. Plants are very sensitive to fatigue and the stimulation must be of such degree and duration that fatigue is avoided if the net result of the treatment is to be beneficial.

It should be noted how uniformly the curves indicate this fatigue effect, Figs. 1 and 6. It is also shown in the effect of alternating current in the soil, indicating that the stimulative effect of a given alternating current in the soil is greater than that of the same current density of direct current.

It is earnestly hoped that investigators more advantageously equipped will continue these and other experiments in this field establishing or altering the above theory so that we may have definite principles by which the effect of a given stimulus may be predicted with the accuracy obtainable in scientific and engineering work.

Panama Canal excavation aggregates, according to the most recently compiled statistics 242,533,216 cu. yd. which does not include 48,238,960 cu. yd. excavated by French companies but not useful to the present canal construction. It is estimated that 19,727,784 cu. yd. of earth are yet to be excavated.

EFFECT OF FORESTS ON RUN-OFF.

BY J. C. STEVENS.
(Continued.)

Percolation.—Liberal percolation of water into the underlying soil is a necessary factor for uniformity of stream flow. We may consider the humus and the soil under a forest as two media of different porosity. If the humus is more porous than the soil, percolation into the soil will be favored; but if the soil is more porous than the humus, less water will percolate than if the soil were directly exposed. A saturated strata is impervious to water, hence in a fine soil the upper layer may become saturated and held in place by capillary action in the overlying humus. In this condition, any additional water simply runs off. The term humus is taken to include all the litter from the surface of the forest floor to the soil underneath it. The upper layers are coarse twigs, leaves, needles, etc., giving place to rotten wood, leaf- and wood-fibers intermingled, and gradually merging into a fine dust-like mold, and finally into the main soil itself. Percolation is the result of two forces, gravity acting downward, and capillarity acting upward. Gravitational forces are constant in all soils, while the finer the soil the greater the force of capillarity. In gravel it is practically negligible, in fine clay it may effectively prevent percolation. If, then, a fine mold overtops a porous soil, less water will percolate than if the porous soil were directly exposed. On a compact soil the mold cannot increase percolation except by arresting the lateral motion of the water and allowing the force of gravity to act longer. In compact soils the amount of percolation is never very great, and the increment due to a humus cover is of the second order of magnitude and can scarcely be of economic importance.

The general claim that the humus gives up its water is directly contrary to physical laws. The forest cover has been likened to a sponge that fills with water which it gradually pays out to the streams. The fallacy of this theory is evident upon reflection. Water does not drain from a saturated sponge except when more water is added. It holds all it receives until saturated. So with the humus (except that the humus is very far from being anything like a sponge); it holds its water until saturated, then water begins to run off and percolate. If the supply is less than sufficient to saturate, the water is evaporated gradually and little or no percolation takes place.

Experiments to determine the amount of rainwater percolating through various soils with various covers have been conducted in European countries, but to the present time no absolute conclusions have been reached on the effect of humus. Dr. Ernest Ebermayer, from a long series of experiments in Bavaria, comes to the conclusion that deep humus imbibes almost all percolation and gives up very little water below. He says: "If our earth were covered with a humus soil of one meter in depth, subterranean drainage would be so slim that springs would be scanty and continuous flowing springs absent."

Very elaborate and careful researches by Dr. Otosky on the steppes and forest lands of Russia, by Professor Morasof in the fir forest of Khrienof, and by Professor Henry of the forest school of Nancy, in the Mendon Forest, France, and by other observations in both Europe and American countries, have demonstrated conclusively that the ground water in forests is at a lower elevation than in the open country. This results from the fact that the trees require large quantities of water for their sustenance and growth. The trees literally "pump" water from the ground and dissipate it by transpiration, and this property has even been put to use in the artificial drainage of marshes. Mr. Lokhtine, in a paper presented to the Tenth International Navigation Congress, held at Milan in 1905, says:

"As a general rule standing on these observations (those of Otosky, Morasof, Henry and others) it seems as though it could be considered as proved that the forest evaporating into the air a large amount of water and withdrawing it from the ground by means of its roots, dries the stratum of the ground into which its roots penetrate, and draws down the level of the subterranean waters. Whence this conclusion, opposed to the former view, that not only does the forest not preserve moisture for the supply of brooks and rivers, but it actually does them harm in this respect. The forest is no longer considered as having more than a certain usefulness in holding back the run-off of surface water. This is the conclusion at which Professor Volny, for example, arrived, and the venerable sylviculture specialist, Mr. Ebermayer, has spoken of it in the same way, although it was on his authority that reliance used to be placed to demonstrate the utility of forests for supplying rivers. He has now changed his opinion and admits that it was incorrect, at least so far as flat countries are concerned. "Forests," he says, "do not increase the quantity of water in springs, but reduce it."

Opposed to this eminently scientific view is the general belief that small springs generally dry up following the removal of forests, but on this point the evidence is so conflicting that no conclusions are possible. My own opinion, gathered from the observation and study of a great mass of literature on the subject, is that a humus cover on soil does not materially affect the amount of percolation one way or the other. On porous soil the humus tends to discourage percolation, while it may increase it slightly on a compact soil; but in either event the increment or decrement for which the humus alone is responsible is of no material value. If this is true the amount that floods are diminished and low stages augmented, is limited to the water-holding capacity of the humus itself. This capacity is very small, and the amount retained from a shower will depend upon its previous condition of saturation. It takes very little rain to saturate a forest litter, and once saturated its power to prevent run-off is exhausted. Moreover, the value of forest litter in this respect must be measured, not by its absolute capacity, but by its capacity in excess of that of naked soil. The results of Dr. Ebermayer's experiments[1] are illuminating on this point. He found that the capacity of the litter in a spruce forest 120 years old was virtually twice that of the naked soil (similar to that under the litter) for the first two inches of depth, but for greater depth the naked soil had slightly greater holding capacity.

The larger openings between sticks and twigs cannot hold a great deal of water. The capacity of

[1]Bulletin No. 7, "Forest Influences," page 146.

humus, therefore, is concentrated in its lower part or in the vegetable mold lying between the soil and this coarser litter. This mold is so light that on steep slopes it does not accumulate to any extent, but is washed into the flatter portions of the area. The total volume and hence the capacity of this layer of water-bearing mold even on an old forested area is utterly insignificant when compared with the volume and water-holding capacity of all the soil and rock formations composing the area. Even in the older forests this mold can never have a volume greater than about 1/10,000 part of the volume of the drainage area, and any increased capacity in the holding power of this slight volume is utterly negligible. Moreover, the needles of conifers and leaves of deciduous trees frequently form a veritable thatch over the litter and humus that allows water to run off without even wetting it. This, of course, is most marked on sloping ground.

The statement is frequently made that a forest litter keeps the soil underneath granular and makes it more susceptible to percolation. That this is contrary to physical laws is also evident upon reflection. The soil of an area must sustain the weight of the trees and the stress produced by winds. In a mature forest from 3 to 5 per cent of the area at the surface of the ground is solid wood. For the first two feet under the surface the quantity of wood is probably 6 or 7 per cent, and all of this soil is compacted into a tight band between the tree roots. Ocular evidence of this is displayed by the masses of earth and boulders that cling to the roots of upturned trees. Such a mass is frequently ten or twenty times the area of the tree trunk, and sometimes resists the erosion of rains and winds for years. Such soil exists under every tree, and it is more than likely that in dense forests 25 to 30 per cent of the soil area is thus compacted into a solid mass. Such a soil is far from granular, and is not conducive to percolation.

With a given quality of soil, the fallow field is the most receptive to percolating water. Meadow lands and pastures are probably second in order, with brush land third, and dense forest fourth.

Evaporation and Transpiration.

These two phenomena in the realm of science are entirely separate and distinct, but for the purposes of studying forest effects they can be considered together.

The water dissipated by evaporation, exhaled by plants, and absorbed by plant growth, represents certain losses that reduce the quantity available for percolation and run-off.

Under forest shade and wind protection, the evaporation from a water surface and from continually wet soil and litter is about one-half[2] that from similar surfaces in the open. Now the absolute evaporation from water surfaces in the United States varies from 30 to 100 in., and in arid and semi-arid regions is ever greater than the annual precipitation. If an annual rainfall of 40 in., say, was uniformly distributed throughout the year (0.11 in. per day) it would practically all evaporate. That it does not is due to the fact that the rain is not uniformly distributed, and the percentage of precipitation that does evaporate is seen to depend almost entirely upon the distribution of rainfall and the climatic influences attending it, while the character of the land surface is of secondary importance. In other words, the amount actually evaporated is governed by the amount of water available for evaporation. This is also true of transpiration. Plants transpire in proportion to the amount of water at their disposal. In a coniferous forest, under average conditions of rainfall, the transpiration is equivalent to from five to ten inches[3] over the area of the forest. If the roots are plentifully supplied with water, trees may transpire several times this amount; or in a dryer soil they may transpire only a fraction thereof, and still live.

The action of a forest cover in this regard must be weighed against that of the open field. After a shower falls in the open, evaporation proceeds at a rapid rate until the upper film of soil is dry, then it gradually diminishes. The grasses and small vegetation continue to transpire water from the upper layer of soil into which their roots penetrate, at a continually decreasing rate. In the forest, on the other hand, a considerable portion is caught in the tree crowns. After a shower the tree tops first dry out at a rapid rate, then evaporation continues from the litter, etc., at about half the rate in the open, but continues for a longer time. Now in every forest there is usually a heavy growth of underbrush, grasses, etc.—frequently as much small plant life as is found in the open—and these transpire large quantities of water from the litter and upper layers of soil, while the deeper roots of the large trees draw from greater depths. Hence, compared with the open, the forest in general evaporates and transpires greater quantities of water than the open field, but from the fact that evaporation takes place at a slower rate in the forest, wooded glades are usually moist, not having an opportunity to dry out between showers. Because of this occular evidence of moisture, the conclusion is hastily drawn that the forest is a great conserver of water, when, as a matter of fact, this moisture in evidence in the forest would either have run-off or percolated into the soil if the forest were not there.

Whatever moisture is evaporated or transpired from an area is lost to the water supply of that region. It depends on conditions, whether this reduction is useful or harmful. Any increase in percolation goes to increase the uniformity of the yield, and uniformity usually is a desirable element in the utilization of water supplies.

Effect on Rainfall.

Until recent years it was quite generally believed that forests increased precipitation. Even the most ardent advocates of that theory now generally admit that forests are the result and not the cause of rainfall, and that they do not influence the distribution of rainfall to any appreciable degree.

The physical causes of rain are not fully understood, but it is certain that the moisture in the air can not be precipitated until the air is cooled below the "dew-point." Air will hold just so much water vapor at a particular temperature. Therefore if sat-

[2] Ibid p. 96-102 and 132-135.

[3] Ibid p. 81.

urated air is cooled, part of the vapor is "squeezed out" of the air. If the cooling is slow, the vapor forms clouds or mist; if rapid, it forms drops which fall as rain or snow. Any influence which tends to cool large volumes of saturated air suddenly may cause rainfall. The most potent influence is dynamic cooling, i. e. by rising to heights where the pressure is less, allowing sudden cooling of air by adiabatic expansion, thus the windward side of mountain slopes deflect the winds upward, and hence receive a large amount of precipitation if these winds are saturated.

Now if forest cover induces rainfall, it must do it by appreciably increasing evaporation, which increase must be precipitated over the same region, or the forest area by some peculiarity must divert rain to itself that otherwise would fall elsewhere. Now forests do generally increase evaporation, but it is never a sufficient increase to materially affect the saturation of the air over them; yet it is plainly evident that to increase rainfall by increased evaporation, the increase in evaporation must materially affect the condition of saturation of the surrounding air. On the second point it is hardly possible that the slight difference in temperature over the forest will produce dynamic cooling of air sufficient to induce rain.

Data on relative amounts of rainfall over forests and open land have been gathered for half a century or more. Only one conclusion can be drawn from them—that if this increase exists, it is less than the observational errors of the methods used, and hence is unimportant economically.

The mechanical effect of forests on precipitation, however, is not negligible. The first important truth is that the tree crowns catch considerable precipitation and dissipate it by evaporation. The long series of European experiments have shown that forest crowns catch about 25 per cent of the annual precipitation. In other words, only about three-fourths of the rainfall reaches the humus and litter. The exact amount of course depends upon the intensity of precipitation. The amount required to saturate the leaves and branches of a forest may be a larger percentage of a light summer shower, but would be an immaterial part of a heavy rainstorm.

The second feature for consideration is the mechanical retarding effect of the litter and underbrush on the run-off. Here again this effect must be weighed against that of the open field. The retarding influence of a sod or of a rocky slope is just as great as that of a forest litter. Under the leaves, twigs and debris of a forest floor, the water filters to lower levels just as surely and as rapidly as it will over the roughened surface of an open hillside with its attendant growth of grasses, weeds or small brush. Among large trees the mechanical retardation is much less than among the tangled undergrowth of open brushland. Moreover, such retarding effect can scarcely be useful even if it existed. Suppose it takes water 30 minutes to run down an open hillside, and suppose that if the same hillside were covered with forest and litter the time would be doubled, the maximum rate of flow in the stream at the foot of the hill would be just as great in the one case as in the other, only it may be delayed a matter of minutes, or hours at most. To make streamflow more uniform the retardation must be effective over much longer periods of time—weeks or months rather than minutes.

Effect on Snowfall.

The mechanical effect of a forest on snowfall is of special importance. It is generally believed that because of the shade, wind protection and reduced temperatures within a forest, melting of snow is greatly prolonged and that the uniformity of run-off is consequently improved both by increased percolation induced and by the continued supply from slowly melting snow fields.

The advantages to percolation from melting snow are no greater than from rains. Snow itself will not percolate until melting occurs, and then the action under a forest litter is in no wise different than if the water were newly precipitated. This feature has already been discussed.

The mechanical influences of trees on snowfall are well known. The initial fall is caught in the crowns. If snow is dry and accompanied by wind, comparatively little is caught in the trees, but if the snow is damp enormous quantities are held in the branches. As much as six or ten inches of soggy snow may lodge in the trees and evaporate directly, none of it reaching the ground. Evaporation from snow is almost as rapid as from a water surface, and especially so when suspended in the trees, becaues of the greatly increased surface exposed. Thus, generally, the forest floor receives less snow than that in the open, as in the case of rainfall. But when snow does reach the ground it forms an even blanket over the surface and no appreciable drifting occurs. The longer the snow lies the more compact it becomes. A layer of snow five feet in thickness may in a few months of ordinary weather shrink to two feet without producing enough water to wet the ground underneath or causing any run-off. This is also true of snow in the open.

In the open land, however, the winds have free play and snow drifts are formed in every gully and in the lee of every obstruction. Exposed knobs or hill crowns may be practically bare, while in the drifts the snow may be ten times the average depth of snowfall. Thus, a given volume of snow in the forest may have twenty times as much surface exposed to melting influences as if the same volume lay in the open.

[To be continued.]

Power from mercury vapor used in a turbine instead of steam is believed by W. L. R. Emmet to be the means of increasing the capacity of an existing steam station by 66 per cent with a gain of 44 per cent output per pound of coal. Mercury is vaporized at 677 degrees F. in a boiler from which it passes at about atmospheric pressure to the nozzles of a turbine. It then passes to a condensing boiler where its heat is imparted to water whose steam is used to drive other turbines. The condensed mercury liquid then runs back by gravity to the mercury boiler. The purpose is to replace steam boilers and to obtain power from mercury turbines as a by-product. Experiments are being conducted in the laboratories of the General Electric Company, for which Mr. Emmet is consulting engineer.

MAKING STEEL BY ELECTRICITY.

BY ERNST M. SCHMELZ.

(This subject is discussed from a practical standpoint. The methods of manufacturing steel are touched upon, the types of electrical furnaces described and the Stassano or pure arc system in particular. The metallurgical operations and the operation of the furnace is referred to and installation and operating costs given. The paper was presented before the Los Angeles Section, A. I. E. E., October 23, 1913.—The Editors.)

Assuming that some of you may not be familiar with the methods used for manufacturing steel, I will refer to them in a few words.

Steel is manufactured from pig iron, the product of the blast furnace, by oxidation of the superfluous carbon and silicon in a Bessemer converter, by simply blowing air through the molten bath. The product thus obtained invariably shows gas enclosures, the process is very difficult to handle, and faulty charges are a frequent occurrence.

Another way is the melting of pig iron and scrap in an open hearth furnace by means of gas produced from oil or coke. If this open hearth furnace is lined with acid brick, it can do no refining, while if a basic lining is used the cost of production is increased, and in any event, the impurities contained in the melting medium—the gas—prevent to a certain extent the refining of the charge.

Up to a few years ago, the only way to produce a high quality of steel was by means of the crucible process. Small quantities—100 to 160 lb. usually—of high grade and very expensive scrap, were melted up in clay and graphite crucibles, heated by oil, coke or gas. While the product of the crucible process can be obtained in very good quality, the method has a number of very great disadvantages. No refining can be done. The raw material has to be of the same high quality as desired in the product. In making a big casting or ingot, the contents of several crucibles have to be poured together, which causes great trouble in timing the pots to be ready at the same minute. The analysis of the steel will differ slightly in each pot, and in addition to all that the cost of fuel and crucibles make this process so expensive that the cost per ton of molten metal varies from $65 to $85, and sometimes even more.

Stassano Electric Arc Furnace at Warman Steel Casting Plant, Los Angeles, Cal.

That is why the steel men the world over are watching with keenest interest the developments of the electric process, which has proved in practice to remedy all these troubles.

Among the hundreds of designs and methods for electric furnaces invented and patented during the past two decades, there are only a very few which have stood the practical test and proved to be of value for the manufacture of steel in a commercial way. We classify them in three groups.

1. **The resistance furnace proper** which produces the temperature necessary for the melting and refining of the steel by the heat developed in the charge itself

when an electric current is forced through it. The current is introduced into the metal either by metallic anodes, as in the case of the furnaces of Gin, or by means of induction, a copper winding in the center of the furnace forming the primary, and the ring-shaped bath itself forming the secondary coil of the transformer. Furnaces of this type have been designed and built by Kjellin, Roechling-Rodenhauser, Frick and a few others.

2. **The combined arc and resistance type,** where the current enters the furnace by a carbon or graphite electrode, forms an arc between the electrode and the bath, flows through the metal and leaves the furnace either by means of another electrode, or through metallic conductors in the bottom. The names of Heroult, Girod, and others are connected with this type.

3. **The pure arc furnace** represented by the Stassano system only, which uses the heat of the electric arc playing between two or more electrodes above the metal without touching the bath.

If I gave a complete description of all these furnaces I fear I would wear out your patience, therefore I will restrict my explanations to the Stassano furnace, which I have been familiar with for the past six years, and which I may say I have helped build up. I will refer to the other systems only if a comparison is necessary to clarify certain points.

More than fifteen years ago, after a long period of laboratory experimentation, Ernesto Stassano, an officer in the Italian army, started to build his first electric furnace. His aim at that time was to produce steel from iron ore, and thereby make his native country, which is rich in ore deposits but unfortunately possesses no coal, independent of foreign steel producers. The first furnace resembled closely an ordinary blast furnace, the tuyeres being replaced by water-cooled carbon electrodes. Stassano did not get very encouraging results with that furnace and changed the design repeatedly before he was able to get the correct form and dimensions for a furnace of the pure arc type, which would answer the practical requirements of the foundry.

The furnace in its present form is equally well adapted for the treatment of ore as for the melting of pig iron or of steel scrap, but the latter process has been worked out to give a complete control of the metal, and has been in practical use for more than nine years, while the ore treatment is still in its infancy.

It may be best here to give a description of the furnace in its present form to facilitate the understanding of its development. The furnace consists of a round or hexagon shaped melting chamber covered by an arched roof and backed by an outer lining of silica or neutral material. Through the side walls of this chamber the carbon electrodes are entered, dropped slightly from the horizontal, and meeting in the center of the melting chamber above the surface of the bath. There are two charging doors and one pouring spout divided equally around the circumference, which provide for the charging of the raw material, the removal of slags, and the pouring of the finished steel. The charging doors are big enough to allow the charging of pieces about 10 in. square, and two feet long. The electrodes enter the furnace through water jackets, and are controlled by means of hydraulic cylinders mounted on the water jackets. By forcing water under pressure between the piston and the front cylinder head the electrodes are pushed into the furnace; by reversed action they are drawn farther apart. These movements change the distance between the ends of the carbon electrodes in the furnace, thereby increasing or decreasing the resistance offered to the arc by the air space, and represent a very effective and simple way of regulating the amperage in the electrodes which stands in direct proportion to the heat developed by the arc. The regulation is effected by hydraulic valves placed on a support near the furnace. The man who operates these valves has one, two or three ammeters, one for each circuit of the furnace. The reading of these ammeters show him if each electrode is drawing its normal amount of current, and directs him to operate the valves in either direction. There would be no difficulty in arranging an automatic device to operate this regulation, but my practice shows that all devices of that sort are complicated, easily get out of order, and tend to make the men inattentive. The regulation needs one man's full attention only when cold metal is brought into the furnace. After the charge is melted the ammeters become so steady that the man can devote most of his time to other duties. The steadiness of the current demand of the Stassano furnace, by which it is distinguished from all other arc furnaces, is caused by the fact that the electric arc in the Stassano furnace is playing between the electrodes only, and does not come in contact with the metal or any other materials of varying resistance.

The melting chamber with all brick material is enclosed in a sheet steel shell, which is suspended from two trunions in a horizontal steel ring. This ring in turn is suspended from another pair of trunions with bearings on supports, the axes of which are at right angles to the first named trunions, thus giving the furnace proper the same suspension as a ship's compass.

To the bottom of the steel shell is attached a short shaft with a ball turned on the lower end. A gear operated by a small electric motor engages the ball and causes it to rotate around an axis perpendicular to the plane on which all four trunions are mounted. The rotating movement of the lower part of the furnace is transformed by the double pair of trunions into a double swinging movement of all the upper parts, and has the effect of thoroughly mixing the liquid metal in the melting chamber during any length of time desired. This not only aids the reaction of the refining slags, but produces a uniform composition throughout the entire charge. This construction greatly simplifies the water and electric connections between the furnace and the main supply. An older design of the furnace accomplished the mixing of the charge by rotating the furnace on an inclined plane, and it was only by complicated and rather expensive devices that the water and electric connections were maintained. Although several of the last mentioned furnaces which I built in Europe have been working for many years without giving reason for complaint, the new design is a marked improvement from the standpoints of simplicity and economy.

Right here is an appropriate time to describe the

metallurgical operations performed in the furnace. Foundry practice demands either the simple melting of a high grade charge, or the melting and refining of inferior raw material to obtain a high grade product. If re-melting alone is your object then the whole operation consists in melting the stock with an addition of lime to bind oxides which enter the bath in the form of rust on scrap with which the furnaces was charged, in removing the slag and in heating the metal up to a proper pouring temperature.

If it is desired to refine a charge, the removal of the impurities—mainly phosphorus and sulphur—is accomplished in the following manner: Immediately after the previous heat has left the furnace, the recharging of the cold scrap begins, and, in the initial charge, it is usually possible to get two-thirds of the capacity; that is, in a one-ton furnace about 1400 lb. can be put at once into the melting chamber. Together with that, a sufficient amount of iron ore and lime is added to oxidize the carbon, and later on the phosphorus contained in the steel. Gradually, as the charge melts, the remainder of the scrap is added, and in about three hours the melting is completed. The bath is now very hot, and sample of the steel taken shows a highly oxidized state of the metal. The phosphorus slag is now taken off, the bath de-oxidized by the addition of a suitable amount of ferro-manganese and ferro-silicon, and the carbon contents of the steel raised to approximately the desired point. Then calcium carbide and lime are added to form a slag for the removal of sulphur. If necessary, this slag is renewed two or three times to accomplish the desired stage of de-sulphurization. After the last slag is taken off, a sample of the metal is poured in a test mould, and the final de-oxidation is done by the addition of ferro-manganese and ferro-silicon; the exact carbon content to give the steel the specified hardness is obtained by the addition of pig iron.

The metal is now ready to pour, and the furnace is tilted by a simple mechanism, until the metal escapes through the spout. Either the entire charge may be at once emptied into a bull ladle or direct into small hand ladles, as is most convenient. To accomplish still further purification, it is advisable to add about 2 lb. of aluminum in the ladle for each ton of steel. To obtain a thoroughly mixed and homogeneous charge, the rotating mechanism is operated at regular intervals during the refining period.

Now, being acquainted with the furnace and its operation, we can determine the operation cost. Taking the one-ton type as a basis, we have to figure on an investment of $3500. This sum includes the furnace, foundation, water and current connections, and engineering service. We will distribute the cost of one ton of molten steel over the different items, as follows:

Cost per ton of Molten Steel.

1.	Current	$ 9.00
2.	Furnace lining	2.00
3.	Electrodes	.96
4.	Labor	3.50
5.	Raw material	10.20
6.	Alloys	1.00
7.	Depreciation and interest on investment	.38
	Total cost per ton of molten metal.	$27.04

In melting and refining our practice has shown that approximately 900 kw.-hr. represents the current consumption, and the average price throughout the country about one cent per kw.-hr.

For one lining approximately 1000 magnesite bricks are used, and the cost, including labor, is $160. This will produce an average of 80 heats, making the cost per ton for this item $2.

Labor item provides for two men for five hours at 40 cents and 30 cents respectively, a total of $3.50.

On melting stock an allowance of 2 per cent is made for furnace loss, requiring 2040 lb. at $10 per net ton.

Depreciation and interest on investment are each figured at 6 per cent, a combined charge of 12 per cent on $3500, which is $420. The furnace will be in operation for 240 days, omitting Sundays and time required for re-lining, and will produce five tons per day, an annual output of 1200 tons. The distribution of $420 over this tonnage shows a charge under this head of 38 cents per ton.

These costs are based on a continuous 24-hour per day operation. If only three heats per day are taken off, making it necessary to keep the furnace under a partial heat while not in active use, the various items will be proportionately increased to make the cost $32.05 per ton of molten metal.

In the first part of this paper, I have pointed out the advantages electric furnaces in general possess over the old methods of steel making. I will now explain why, among all electric furnace systems in use, I am giving the preference to the Stassano furnace.

From a close study of theory and practice in electric steel, extending over many years, I find that there are certain qualifications an electric furnace must have to come as near perfection as modern science will allow. These qualifications are as follows:

Metallurgical Properties.

1. All metallurgical operations must take place in an atmosphere chemically neutral, so that bath and slag are protected from all outside chemical influences.

2. The transformation of the electric energy into heat must take place at the highest obtainable temperature, so that any desired temperature in the bath or slag can be obtained.

3. A compact area to the surface of the bath, and means to provide easy access to it.

4. If desired it must be possible to let the bath stand for any desired length of time, perfectly quiet under the influence of the heat to give gases and slag enclosures time to rise to the surface. At the same time it must be possible to mix the charge thoroughly in a mechanical way if so desired.

Electrical Properties.

1. Adaptability for every kind of current, voltage and number of cycles.

2. Use of as high a voltage as is consistent with safety for furnace and men, at the same time avoiding all high pressure current on the furnace itself.

3. A simple and safe method of regulation.

Mechanical Arrangements.

1. Efficient tilting arrangement.

2. Simple and strong construction, giving highest guaranty against accidents.

Economical Features.

1. Low cost of installation and up-keep.
2. High factor of efficiency.
3. Adaptability of one type for all purposes.

If we investigate, we find that the Stassano furnace meets the above named conditions. The neutral atmosphere is perfectly obtained. All doors and openings are tightly closed during the operation; the electrodes do not enter the bath, and the lining is neutral. The temperature of the electric arc is the highest of all heating mediums known to science, it being estimated at 6300 degrees Fahrenheit. This heat is equally distributed over the entire surface of the bath, and notwithstanding the enormous heat the burning of

Exterior View of Warman (Electric) Steel Casting Company's Works, Los Angeles.

the metal is impossible on account of the absence of an oxidizing atmosphere. The surface of the bath is square, hexagon or circular. There are no side channels. The large doors make the charging of the furnace and the handling of the slag as easy on a small type of furnace as on a large one. The rotating movement of the bath for mixing purposes can be stopped at any desired moment to allow the metal to rest.

The Stassano furnace is the only one which can be run by direct current as well as any kind of alternating current of any voltage, single, two or three-phase; and the number of cycles is immaterial. The voltage used is from 110 to 150, or on larger types, up to 225. It is never necessary to use high voltage in the furnace. The hydraulic regulation of the current by hand levers is both accurate and dependable.

The tilting mechanism, as previously outlined, is very efficient, and all parts of the furnace are built strongly with a high safety factor. The cost of construction given before show it to be less than required by other systems. The high factor of efficiency of the Stassano furnace is shown by the low energy consumption.

The same type of Stassano furnace, outlined here, can be used alike for melting pig iron or steel scrap, for cold or molten charges, and can even be used for the reduction of ore.

As a special feature of the Stassano furnace, I want to call your attention to its small furnace loss. The Bessemer process shows a loss of from 15 to 20 per cent (difference in weight between the product and of the raw material charged); the open hearth and other electric furnaces show 10 per cent. The Stassano furnace keeps that loss down to 2 per cent or even lower. Not only does this give an increased production of 8 per cent without additional cost or time, but it renders the furnace especially valuable for the manufacture of the chromium, vanadium, nickel and other alloys of steel.

I hope the foregoing will give you an idea of what an important revolution in the steel industry the electric furnace is bound to create, and how well it is able to open up new fields for this industry in places where fuel is expensive and the "white coal," as the French call the hydroelectric power, is cheap.

LETTER TO THE EDITOR.

San Francisco, January 16, 1914.

To the Editor:

The editorial on a "Corporation With a Soul" in your issue of January 10th meets with my full approval.

The "soulless corporation" phrase was the figment of the brain of some irresponsible newspaper man seeking agitation against public utilities. In my judgment, the corporations have vastly more soul than most organizations, including political ones, and largely more than most individuals.

The soul of a corporation is the personal equation of management and is reflected in subordinates. Affability and courtesy and some belief in the rights of others creates the condition of the soulful corporation —the absence of it that of the soulless, if there is such a thing.

I do not believe that regulation has had anything to do with the change in aspect of corporations—merely the necessity for self-protection, which is predominant in corporations as well as individuals. As the business of corporations has increased vastly and has come into contact with more and various kinds of people, it has become unconsciously better and formulated conditions for dealing with them on right principles.

Such an editorial as you have published will certainly be productive of good.

Yours very truly,
(Signed) JOHN A. BRITTON,
Vice-President and General Manager,
Pacific Gas and Electric Company.

The 1913 copper production of the United States according to the estimates of the Geological Survey, was 1,223,700,000 lb. of blister and Lake copper as compared to 1,243,268,720 lb. in 1912. At an average price of 15.3 cents the 1913 output has a value of about $187,200,000, against $205,139,338 for the 1912 output, Preliminary statistics showing the output of refined copper are not collected by the Geological Survey. Figures published by the Copper Producers' Association show an output of 1,483,480,408 lb. for the first eleven months of 1913 and indicate that the production of marketable copper by the regular refining plants from all sources, domestic and foreign, will amount to 1,618,000,000 lb. for 1913 if the December output is equal to the monthly average for the first eleven months. This compares with 1,568,104,478 lb. in 1912.

LIGHTING METHODS

A VINDICATION OF PROPER LIGHTING METHODS

BY A. L. POWELL

(This comparison which shows the wonderful improvement in den lighting due to the use of proper methods, is abstracted from a paper which Mr. Powell read before the New York Section of the Illuminating Engineering Society on January 8, 1914, on some interesting changes made in the lighting of a private home where an inefficient and inartistic installation was replaced with one in which the essential features are eye-protection, artistic appearance, good diffusion, and economy.—The Editors.)

This is a relatively small room 11 ft. x 10 ft—110 sq. ft. (3.35 m. x 3.05 m.—10.22 sq. m.) used for reading, playing cards, writing, etc. Fig. 1 shows the old lighting equipment a combination gas and electric multi-arm chandelier, which was inadequate, as well as unattractive. Three 50-watt clear carbon lamps with pressed glass shades were in use; the lamps being installed at angles of 45 degrees with the vertical and but 6 ft. 6 in. (1.98 m.) above the floor, they were controlled by key sockets. The glare was extreme; there was practically no diffusion, and the distribution very unsatisfactory, a condition which was particularly noticeable when one played cards on the table located in the center of the room. The direction of light was such as to place the faces of the cards into shadow.

Fig. 1. A Fixture Both Inartistic and Inefficient.

The fixture was replaced by a totally indirect unit (see Fig. 2) consisting of a one-piece mirrored glass reflector in a casing of an Egyptian design which has sand blasted finish and brushed brass high lights. The chain suspension is of such length as to bring the lamp 7 ft. 3 in. (2.21 m.) from the floor. A 100-watt clear tungsten filament lamp is used, controlled by a pull switch in the base of the fixture.

Although the ceiling is white, the walls are of dark green paper with a brown wainscoting, which causes the illumination efficiency to be relatively low. The distribution is good and the general effect pleasing. The intensity is sufficient for the conditions to be met, yet it is not high enough for fine work, such as sketching, etc., and it is planned to install a baseboard receptacle near the desk and use a suitable local lamp at the desk when required. A suitable intensity could be secured with a larger lamp in the center outlet, but from the standpoint of economy the first scheme seems desirable.

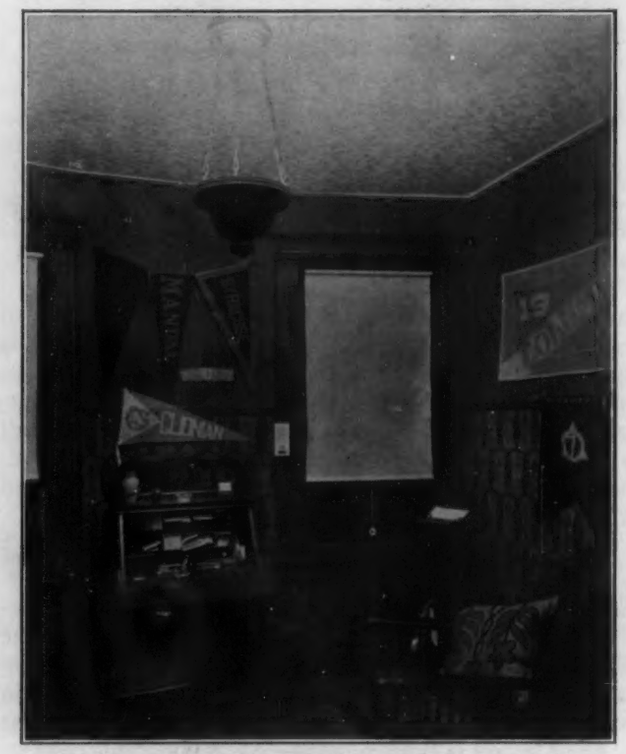

Fig. 2. Improved Illumination and More Artistic Appearance, With Greater Efficiency.

Illumination Readings.

Stations.		Actual illumination old equipment.	Illumination old equipment corrected to 3 50-w. 2.97 w. p. c carbon lamps.	New equipment tungsten filament lamp at 1.08 w. p.c.
A	3 ft. (0.91 m.) horizontal	0.60	0.69	0.96
	45° toward light.....	0.96	1.09	1.42
B	3 ft. (0.91 m.) horizontal	0.51	0.58	1.28
	Vertical top bookcase..	0.81	0.92	0.94
B	Vertical bottom bookcase	0.25	0.29	0.30
C	3 ft. (0.91 m.) horizontal.	0.40	0.46	1.09
D	Horizontal desk level..	1.42	1.62	1.73
D	Horizontal desk level shadow test-writer in position	0.73	0.83	1.69
E	Horizontal typewriter level	0.56	0.64	1.19
	45° toward light	1.07	1.22	1.56
F	3 ft. (0.91 m.) horizontal	4.10	4.70	2.30
G	45° plane away from light position of paper in reading	0.91	1.04	0.87

METHOD IN HOME LIGHTING.

(Continued.)

1. The Entrance Gate.

In the West we have built hurriedly, and custom is excluding somewhat the vast possibilities which lie in the proper treatment of the entrance gate. This is especially true where so many suburban homes exist on streets none too brilliantly lighted. As a matter of fact the entrance gate is conspicuous by its absence.

There is no reason against the development of this feature. It is something we have forgotten. Something which could be made distinctive and give character to the dwelling. At the same time it could be made useful if properly lighted.

A wide range of lighting fixtures is therefore possible, from those installed upon brick or stone piers—usually in the form of lanterns or of old style street lamp design, or again, of a style to give a finished appearance to the piers—to the all metal and more simple for the much smaller homes.

This is a possibility though with all and well worth careful development.

Where the residence is sufficiently pretentious the side entrance should be properly lighted and the outside of the stable or garage. A three-way switch should be provided so that the lights may be turned on or off from the front of the house or the outbuilding.

2. Outside Decorative Lighting.

If it is at all possible that outside decorative lighting will be used on special occasions then one or more circuits should be run to convenient points to there terminate in weather-proof boxes containing branch blocks with fuse plugs for protection of the rest of the system. This will save much of the additional wiring expense later as special festoons of lamps can be kept on hand to be merely connected to these branch blocks at any time they may be required.

3. Veranda and Porch.

Adequate veranda and porch lighting is good burglary protection and if for this reason alone, should always be provided.

The choice of units hinges largely on the style of veranda—whether small or extensive; sides open or enclosed; ceiled or with open rafters.

It is important, however, to bear in mind that all outside lighting units, that is, those exposed to the weather, should be of a style that will require minimum cleaning. Not that there is any excuse for neglecting to clean lighting equipment, but it is a weakness of human nature to omit the attention due those things which faithfully perform their duties with a minimum of necessary care.

Neglect in cleaning electric lighting equipment was also excused on account of the fragility and consequent high rate of "infant mortality" of the early types of tungsten filament lamps. There is now, however, no excuse for neglect on this score, for present day tungsten lamps are sufficiently rugged in construction to permit frequent handing. Both from the viewpoint of appearance, efficiency and sanitation, cleaning is essential whether the units are within or without, but in the latter case it is the part of wisdom to install as stated, only those units which will suffer least on these points as a result of weathering the elements. Those which will also withstand the attacks of moths and other winged insects which, although they cannot singe their wings will still flutter about the light until exhausted. Their strivings to get as close as possible to the light leads them to the smallest opening, into which they crawl and die—to the detriment of the appearance of the lighting unit. All of these bad features may be avoided or minimized by careful selection of the fixtures and glassware, a large variety of proper design being available for this purpose.

Utility must not, however, be subordinated to appearance. As with the lighting at the entrance gate so that on the porch is a mark of distinction and of character, but on the other hand the mild weather of the West invites so enticingly to the cool of the veranda during the evening hours that sufficient illumination should be possible from these lighting units to permit card playing, reading, and so forth.

Two systems might be advantageously provided, (1) a decorative fixture giving average illumination for general use, and (2) good general illumination for special occasions.

For ceiling units balls or globes and hemispheres are most popular and practicable, but due to the effect of the weather spoiling the appearance and lowering their efficiency, crystal rough inside (C. R. I.) glassware should not be used. Much prettier effects can be secured by the use of light density opal glassware such as that made under the trade names of Alba and Veluria, and with the outside surface glazed. Such glassware does not deteriorate through exposure to the weather and its additional cost is easily saved on account of the much lower absorption of light and higher illuminating efficiency, which permits the use of lower wattage lamps.

It is perhaps unnecessary to mention that all outside fixtures should be of a material and finish which will withstand the disintegrating effects of the weather.

[To be continued.]

To hold lamps in their sockets where vibrations are likely to shake them out, merely put a rubber band over the threads on the base. The friction is sufficient to keep the lamps in place.

Ductile tungsten for incandescent lamp filaments is made by repeated hot-workings of sintered tungsten powder. The metallic powder is reduced from the purified oxide by gradual and long-continued heating to about 1000 degrees C in a hydrogen atmosphere in a porcelain or quartz tube. The powder is pressed into an ingot, sintered at a white heat by the passage of an electric current and then passed through about forty dies to slowly reduce it from a ¼ in. billet to a ½ millimeter filament. The whole process requires great care and time to convert the metal from a crystalline to a fibrous structure. The final filaments are pliable and ductile at ordinary temperatures, and are exceedingly strong and tough.

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E. B. STRONG, President and General Manager
A. H. HALLORAN, V. P. and Managing Editor
ROBERT SIBLEY, Treasurer and Editor in Chief
C. L. CORY, Secretary and Special Contributor
A. M. HUNT, Director and Special Contributor

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Letters to the Editor

Every institution may be but the lengthened shadow of a man, but in course of time the shadow of the individual must give place to the substance of collective effort if the institution is to fulfill its highest purpose. This is especially true of the technical journal which is a system colossal, in that it is nation wide—international even—in its scope and service.

Recording progress, the technical journal points to the possibilities which progress contains.

In the electrical field there is nothing so constant as change. While one man says that it cannot be accomplished, another man does that very thing. As one man is describing the "best" way, another evolves a better. Everything is conditional only. Not the best possible, but the best possible at that time.

Bigger, broader and better issues are a natural result of those just fought out.

"The truth is in the air," wrote Emerson, "and the most impressionable brain will announce it first, but all will announce it a few minutes later."

But the most impressionable brain does not always announce or record although it may be the first to discover. Such discoverers have their own thoughts speak to them from the printed page with a certain alienated majesty, for they are clothed in the words of others.

If on reading an article you detect the further progress which that article suggests, it is both your duty and privilege to give expression to the newly generated idea or different viewpoint.

Light is yours that you may bear witness to that light.

Time was when subscribers thought that the payment of a journal subscription merely meant that a certain number of issues paid for in advance had secured to them a substantial reduction. Now they know that it is merely an indication on their part that they wish to participate in journal service. This involves co-operative effort—giving as well as receiving.

Each individual in a collectivity must do his part if the greatest measure of success is to be realized for all.

As a matter of reciprocity and mutual benefit, every reader owes it to every other reader to give expression to his ideas whenever they differ from those generally accepted or from the published information.

If the reader will do his part we may be relied upon to do ours.

This journal is at once a source and a reflector. A unit composed of many master minds. These generate the ideas which are concentrated by this journal and reflected in its pages.

Our reflector has a wide distribution. A vast audience is assured which will listen eagerly to the exposition of your thoughtful purpose.

But unless the new idea, the different way or viewpoint is expressed, and "the most impressionable brains gets action, it is impossible for us to express it. To that extent the source burns under voltage.

Because this journal is a reflector we are prepared at all times to project from its pages ideas which are different, both sides of a question, and the possible better way.

In the January 10th issue was published the Forestry Department's view of a certain question, the other side of which had previously appeared in our pages.

Last week we published a letter to the editor sent by an Eastern engineer who congratulated us upon a new department of Journal service recently inaugurated.

In this issue is published a letter from an official of a large corporation in which he amplifies one of our recent editorials and so gives other readers a still more comprehensive idea of the subject of the soul of a corporation.

It is but natural that all letters received cannot be published, but it is our desire to publish all those which will tend to add to the sum of human knowledge, and once in a awhile those also which express the responsive, "Well done!"

Our columns are open for the use of our readers.

Lighting and the Eye

Those creatures which venture abroad principally at night have eyes different in some respects from those of humans which are more used to daylight conditions. This is due to environment; the adjustment of the instrument to the condition met. It is impossible to conceive of a time when mankind did not perform during daylight those functions which depend upon the use of sight, for the nightfall brought a darkness which it seemed futile to attempt to dispel. A darkness which to an unenlightened mentality, was tangible enough to be felt.

The eyes, never put to a really great strain, enjoyed periods of rest at least equal to the hours of use. Conditions are now vastly different.

At a comparatively recent date the illumination of floors in the aisles of picture theatres running a continuous performance, made an additional innovation in lighting methods. The object was to permit people to find or leave their seats without the necessity of turning on any general lighting. It was a system short lived although these transparent floors were illuminated to a very low intensity, and green light chosen as a color calculated to be restful, notwithstanding also the contrast of the greater intensity of illumination reflected from the picture screen. The result was confusing.

There was the same effect on the eye, although differing in degree, as is produced on a bright day when even squinting, the utmost method of naturally protecting the eye, fails to adequately minimize the eye-strain. Sunlight reflected from snow is even worse and colored glasses often fail to effect the needed protection.

Yet the same intensity of light coming from above the horizontal, causes little or no trouble. The difficulty in the other cases mentioned is that the light comes from below—a condition which the eye has not been called upon to habitually meet and to which it cannot be adjusted. Nature's requirements urge conformation.

The ease with which darkness is now eliminated, thus extending the hours of use and equally reducing the periods of rest, the closer and more constant work which has to be performed, and the careless and inconsiderate installation of inadequate lighting systems, are placing an increasing burden upon our organs of sight.

The increasing number of those wearing glasses is not the result of wider knowledge ameliorating untoward conditions which have always existed though not known, but is evidence of the abuse of this most valuable of the nation's resources—the people's vision.

That the eye will adjust itself over a wide range of intensities of illumination is uncontested, but grave dangers are consequent upon persistent or radical departures from those conditions to which the eyes have become habituated over a long period of time.

Great latitude in planning lighting installations is not allowable. They must not differ very much in principle, from actual daylight conditions.

Such lighting must be steady, of proper quality, sufficient in quantity, come in a downward oblique direction, and be well diffused.

The conservation of vision will be emphasized throughout the articles appearing in our pages devoted to Lighting Methods and the co-operation of all readers to this end, is urged.

Averages Increased Electrically

Only those who have checked the agricultural returns for a whole state or territory know how the averages are lowered through poor yields. The average results in no way indicate the possibilities of the soil. They are rather an adverse comment.

These low yields are in large measure due to incompetency. The city-bred youth, reading of the remarkable returns garnered from the soil resolves that he, too, will do likewise. To plow and sow, reap and gather the harvest. His disappointment occurs when he finds that the ground will not laugh a harvest in response to the tickle of his easy effort. Probably his experienced neighbor reaps sixty bushels to the acre while he reaps but five.

Knowledge of advanced farming methods—the science and art of agriculture—is essential to success, a success in which all the people are intensely interested for it is the foundation of the measure of every nation's prosperity.

Improved methods have resulted in increased crops. Care must be taken, however, that the ground is not impoverished and there must always be returned to it, the elements essential to plant growth.

The power of electricity in fixing nitrogen is contributing to this end.

But the network of power wires which stretch out and across our Western agricultural districts may yet offer to the farmer an easier method of accomplishing the desired end of inducing from the soil its utmost wealth. A further possible central station service looms large on the horizon.

In this issue is published the results of some remarkable advantageous effects produced upon plant growth through electric stimulation.

While there is much of experimentation to be yet made along this line, investigations should be stimulated by those most interested, for reduced to an exact science this service which would be welcomed by the farmer, should contribute largely to the national wealth.

PERSONALS

ITEMS FOR THIS DEPARTMENT ARE SOLICITED FROM ALL READERS

F. N. Averill of the Fobes Supply Company, Portland, Oregon, is at San Francisco.

H. C. Thurston, electrical contractor of Ukiah, Cal., was at San Francisco last week.

Andrew Carrigan, of Dunham, Carrigan & Hayden, has left for Chicago and will visit other Eastern cities.

H. V. Carter, president Pacific States Electric Company, spent the past week in Southern California on business.

J. L. Stannard, consulting engineer, Portland, Oregon, announces the removal of his offices to room 614 Lewis Bldg.

Romaine W. Myers, consulting engineer, Oakland, Cal., has been elected a member of the Illuminating Engineering Society.

A. D. Hotson, senior member of the firm of Hotson & Gillies, Vancouver, B. C., has been elected a member of the A. I. E. E.

Roy W. Gray, division plant superintendent of the Western Union Telegraph Company has returned to San Francisco from Los Angeles.

Glenn B. Walker, commercial engineer of the Utah Light & Railway Company, has returned from a three weeks' visit to his home in Michigan.

F. N. Cooley, Western Electric Company, left San Francisco last week for Washington, where he will occupy a position with the Seattle branch of the company.

C. F. Conn, engineer with J. G. White & Company at San Francisco has been transferred to the grade of member in the American Institute of Electrical Engineers.

Marshall Tiebout Gleason, of the Gleason Tiebout Glass Company, New York, is at Salt Lake City and will visit the principal cities on the coast before returning East.

E. S. Berdine, western representative Gleason Tiebout Glass Company, manufacturers illuminating glassware, has left San Francisco for a business trip throughout his territory.

S. P. Russell, manager electrical department H. W. Johns-Manville Company, San Francisco, will, with **J. W. Thompson**, illuminating engineer leave for New York on a business trip during the latter part of next week.

Charles L. Edgar, president Boston Edison Company, Boston, Mass., was guest of honor at a luncheon given at the Bohemian Club by **John A. Britton**, vice-president and general manager Pacific Gas & Electric Company.

Hal Lauritzen, manager western division, Holophane Works of General Electric Company, has returned to San Francisco, but will leave almost immediately on a special business trip through the Pacific Northwest.

A. J. Myers, Pacific Coast Manager, Wagner Electric & Manufacturing Company, is at Los Angeles and will leave Saturday (24th) for the East, where he will visit the Wagner factory at St. Louis. He expects to be gone a month.

Geo. C. Moore, who, with English associates, is to finance the properties and assume control of the various subsidiary companies of the United Properties Corporation, has left San Francisco for New York and London, to complete the arrangements.

C. R. Hummerick, previously with Fobes Supply Company, Portland, Ore., and **W. H. Merrill**, who has been with the Lewis Electric Company, Boston, Mass., for the past nine years, have joined the sales force of the Electric Appliance Company, San Francisco.

Robert H. Parker, local manager of the Butte office of the General Electric Company, stopped over in Salt Lake City last Saturday, on his way to Chicago. He reports the prospect for business in Montana during 1914 as being brighter than during several years past.

C. P. Lindsley, the Lindsley Brothers Company, **W. M. Leavitt**, National Pole Company, and **M. P. Flannery**, B. J. Carney & Company, Spokane, Wash., were appointed members of the Pole committee of the Western Red Cedar Association, the first named being chairman.

H. W. Fielding, superintendent of construction, Western Canada Power Company, Ltd., Ruskin, B. C., and **E. R. Perry**, draftsman, Puget Sound Traction Light & Power Company, residence Waldorf Hotel, 7th and Pike streets, Seattle, Wash., have been elected associate members, A. I. E. E.

Ellis G. Brode, formerly in the Boston office of the General Motor Company, has accepted a position with the Capital Electric Company as electric vehicle specialist. They intend to go actively after the vehicle business in this territory, as the considerable amount of street paving recently completed and in progress renders the use of motor vehicles in Salt Lake more feasible than heretofore.

MEETING NOTICES.

Oregon Electrical Contractors' Association.

The Oregon Electrical Contractors' Association had its regular meeting at 6:30 p. m., January 14th, at the Portland Commercial Club. The "new price book" was distributed to the members at this meeting.

The Utah Society of Engineers.

The regular meeting of the Utah Society of Engineers was held on Friday, January 16th, in the Consolidated Music Hall, 15 East 1st South, the new quarters of the society. J. B. Scholefield, public accountant, read a paper on engineering and accounting, with special reference to public utilities, and A. M. Nelson, assistant engineer of the Oregon Short Line, gave an address on the subject, "The Physical Valuation of Railroads." An interesting discussion followed the presentation of these papers.

Portland Sections A. I. E. E. and N. E. L. A.

It is proposed to hold an informal dancing party on the evening of January 27th, at the Multnomah Hotel, under the auspices of the Portland Sections of the National Electric Light Association and American Institute of Electrical Engineers. Invitations will be sent those signifying their intention to attend the dance. There will be no charge for admission. Those desiring to attend are requested to notify R. F. Monges, secretary, care General Electric Company, Electric Building, Portland, Oregon.

San Francisco Electrical Development & Jovian League.

The regular meeting was held last Tuesday at Tait's Cafe. The League as a body endorsed the action of the executive committee in directing the attention of the civil service commission to the necessity and justice of continuing the present appointee in the position of chief electrical inspector instead of automatically removing him by insisting that this position be a civil service appointment. Encouraging progress was reported.

A paper was presented by H. E. Grant on "Why different lighting systems," in which the history of electric lighting was briefly outlined and the various fundamental systems defined and described, also the proper use and limitations of each system. There was a good attendance.

The Utah Electric Club.

At the regular luncheon of the Utah Electric Club at the Commercial Club Thursday, January 15th, the first order of business was the installation of officers for the ensuing year. President W. W. Torrence briefly outlined the proposed activities for 1914 and announced the appointment of the regular standing committees. These committees and their chairmen are as follows: Commercial Organization, Lafayette

Hanchett, National Copper Bank; Membership, J. P. Sprunt, Westinghouse Electric & Manufacturing Company; Social and Entertainment, L. E. Brown, Westinghouse Electric & Manufacturing Company; Athletic, W. A. Moser, Westinghouse Electric & Manufacturing Company; Employment, H. T. Plumb, General Electric Company; "Round-Up," H. J. Brown, Mountain States Telephone & Telegraph Company.

Electric Show Association of Utah.

The annual meeting of the Electric Show Association of Utah was held at the Commercial Club on Thursday, January 15th.

This association was incorporated four years ago by the electrical interests of Salt Lake City and the state of Utah for the purpose of conducting electrical expositions at such times as the general conditions of business warrant. The first show, held in October of 1910, was a complete success from every standpoint.

At the annual meeting Thursday the following officers were elected: Bayard W. Mendenhall, president; C. B. Hawley, vice-president; W. W. Torrence, secretary; J. C. Gleeson, treasurer.

It was decided to hold an electric show in April of this year, and the meeting was adjourned until next Thursday, when the committees to handle the show will be appointed and active work started.

Western Red Cedar Association.

At the regular annual meeting of this association held at Spokane, Wash., Monday, January 12, 1914, President Culver in presenting his annual address, remarked, "We should also use our utmost efforts to have the National Electric Light Association adopt our specifications for cedar poles. Large quantities of poles are purchased annually under specifications suggested by that association and the advantages, therefore, of the desired action are obvious."

After a short discussion the committee on the Forest Products Exposition was instructed to take up with the National Electric Light Association the matter of having specifications for western red cedar poles adopted by that association. At the present time the National Electric Light Association have specifications covering yellow pine poles, Eastern white cedar and chestnut poles, but have none covering the western red cedar. It is the belief of the association that the western red cedar poles are far superior to any of the other three now covered by the specifications of the National Electric Light Association, and it is therefore hoped that during the year 1914 specifications will be adopted by the National Electric Light Association for the western poles.

The meeting was adjourned subject to call of the president. During the noon hour the association adjourned to Davenport's restaurant where an informal luncheon was held in the east room.

ELECTRICAL CONSTRUCTION ACT.

The Washington public service commission has appointed a committee of sixteen to draft amendments to the electrical construction act. The commission is of the opinion that there should be more standardized requirements applying to all companies. As soon as this committee reports, the hearing on the subject which was started on November 3 at Seattle Chamber of Commerce assembly room, will be resumed. The members selected are E. L. Ritter, representing telegraph companies; N. C. Nelson, municipal plants; N. W. Brockett, large power and light companies; J. S. McGee, small power and light companies; W. T. Teague, large telephone companies; John Wilson, small telephone companies; R. K. Reed, signal service; H. E. Durant, H. H. Emerson, R. Nesbit and M. Blair, the unions; George Quinn, electric railways; E. A. Kippel, steam railroads; A. E. Boyles, electrical expert for the commission; J. F. Reardan, inspector of tracks and safety appliances, and M. Vetter, his assistant.

SPECIAL TRAINS TO INTERNATIONAL ELECTRICAL CONGRESS, SAN FRANCISCO, 1915.

Plans are already well under way for special trains from the East in connection with the International Electrical Congress to be held at San Francisco in September, 1915. The trains will represent the last word in safety and comfort, and their itineraries will be laid out to include the finest scenery in the country.

The tentative program, which at a later date will be submitted in detail to the engineers of the United States and other countries for an expression of their individual preferences, includes a round trip of about 30 days' duration with stops in Chicago, Colorado Springs, Salt Lake City, San Francisco, Santa Barbara and Los Angeles. At each one of these places, special arrangements will be made by local committees for the comfort and entertainment of the members of the party.

Other features of the trip will be the Royal Gorge, the Feather River Canyon, and a four-day visit to the Yellowstone National Park on the way out, with a 24-hour stop at the Grand Canyon on the way home.

Should the demand justify it, a special train will also be provided from Chicago straight through to San Francisco to take care of those with whom time is a prime consideration.

The transportation committee of the congress is further considering the possibilities of marine transportation by way of the Panama Canal. There appears to be a considerable demand for this, especially if satisfactory arrangements can be made for combining the land and water features.

NEWS OF THE PUBLIC UTILITIES COMMISSION OF IDAHO.

The Swann Creek Electric Company was granted a certificate of public convenience and necessity to construct a transmission line from the Utah-Idaho state line northerly to Fish Haven and to serve that village, but was refused an extension through to St. Charles on the ground that the Utah Power & Light Company is already serving that village, the business from which does not justify a duplicate system.

J. D. Browning of Pocatello, Idaho, was granted a certificate that the present and future public convenience and necessity requires the construction of an electric street railroad within the city limits of Pocatello, Bannock county, Idaho, for passenger, freight, express and mail traffic.

The Great Shoshone & Twin Falls Water Power Company was ordered to at once cease its practice of withholding the collection of its accounts in the towns of Gooding, Glenns Ferry and Mountain Home for electrical service rendered, as this had been construed by consumers in other villages and cities served by this company as a discrimination against them. The commission ordered an investigation of all rates charged by the company and also by the Beaver River Power Company and the Idaho Power & Light Company hearing being fixed for the 26th of January, 1914.

TRADE NOTES.

The Central Electric Company has been awarded the contract for the installation of electric lights on H street, between State and Sixteenth, San Diego, and the Barth Foundry & Machine Company has been awarded the contract for furnishing iron posts.

The city council of Santa Monica has awarded the contract for the installation of a lighting system in Fremont avenue from Ocean avenue to Eighth street, Santa Monica, Cal., to Woodhill & Hulse Electric Company for $4775 for a lighting system complete.

Owing to rapidly developing business the Olston Electris Stove Company, Los Angeles, will shortly move into a new factory at Twelfth and Central avenue. The new place covers an area 100x125 ft. and will contain all modern facilities for the manufacture of electric stoves.

NEW CATALOGUES.

(Under this heading attention is directed to cata logues and bulletins representing the latest information upon the subjects treated. The latest developments are always in advance of the most up-to-date text books. Readers are urged to write direct to the publishers for these catalogues and bulletins, which, unless otherwise stated, are available for free distribution.)

The General Electric Company recently issued Bulletin A4176, describing its High Voltage Oil Break Switch, known as Type F, Form K-15. This switch may be operated by several methods described in the bulletin, which supersedes the previous one on this subject.

Bulletin A4167 is devoted to the subject of Electricity in Iron Foundries. It is profusely illustrated with typical applications of G-E motors in iron foundries, and contains a chapter on Foundry Lighting. For those looking for information on this subject, the bulletin should be of great interest.

Motor-Driven Exhaust Fan Outfits is the subject of Bulletin No. A4174, published by the General Electric Company, and devoted to the subject of fans for ventilating purposes. It contains, in addition to other data, illustrations and dimension diagrams of the various motors built by the company for this purpose.

The General Electric Company has just issued Bulletin No. A4178, describing their Three-Phase Induction Motor Panels for controlling induction motors of voltages of from 110 to 2200, 25 to 60 cycle circuits. The panels are not intended to be assembled as part of a switchboard. The bulletin contains a long list of standard panels, among which can be found panels suited to practically all conditions of service of this kind.

In Bulletin A4151, recently issued by the General Electric Company, are described that company's Engine-Driven Continuous Current Generators of the commutating Pole Type. These are manufactured in both two-wire and three-wire styles, either shunt or compound wound, 115 to 125, or 230 to 250 volts. They range in capacity from 25 to 400 kw., inclusive. Data on larger sizes, wound for 250 volts only, will be furnished on application.

Baldwin-Westinghouse Electric Mine Locomotives is the title of a pamphlet which has just been issued by the Westinghouse Electric & Manufacturing Company at East Pittsburgh, Pa., and the Baldwin Locomotive Works, at Philadelphia. The pamphlet describes the new barsteel frame locomotive and its advantages. The various accessories, such as controllers, circuit breakers, trolleys and gathering reels and described and illustrated. Specification blanks for mine haulage locomotives are included.

"Motor Driven Refrigerating and Ice-Making Machinery" (Section 3133) issued by the Westinghouse Electric & Manufacturing Company describes the process employed in this class of work and illustrates the application of electric motors thereto. A number of installations are shown and a curve is given from which the horsepower required for different tons-capacity machines can be determined. There is also included a table showing the type, capacity, and speed of motors required for the different machines in a refrigerating plant together with the kilowatt hours consumption. These tables are compiled for several different plants.

The Crocker-Wheeler Company has issued a Bulletin (No. 160) on "Induction Motors for General Use" that in illustrations and character of text departs widely from the usual publications of its kind. Half-tone illustrations are entirely excluded, all cuts being in line, thereby bringing out sharply the various details to which attention is directed. Instead of reading matter which endeavors to satisfy at once the average reader and the technical man, the first part of the Bulletin is addressed to the former, while some pages at the end are devoted to technical remarks that appeal more particularly to the electrical engineer. By judicious condensation an unusual amount of information is comprised in the 19 pages of the Bulletin; yet the text is so clearly worded that reading requires no effort, and the understanding of the illustrations is facilitated by full descriptive captions. In illustrations, in development of subject and in the use of clear-cut language the Bulletin is a great advance.

The Westinghouse Electric and Manufacturing Company has just issued a number of pamphlets covering railway line material. Catalogue Section DS840 covers Suspensions, Ears and Splicers. Different types of trolley suspensions are illustrated and described; also various accessories, such as expansion bolts, insulators, clinch ears, trolley splicers, strain ears, wire chucks, etc., are listed and illustrated in a convenient manner. Section DS841 covers frogs, crossings, section insulators, switches and lightning arresters. The Detroit trolley frog and other types are fully described and illustrated; also different types of trolley crossings, both rigid and adjustable. In the lightning arrester section, pole type lightning arresters, together with fittings, such as ground plate, ground point and cap, grounding bonds, etc., are described, together with the proper method of making ground. Section DS844 covers strain insulators of various types and for different kinds of service. Section DS850 covers rail bonds and bonding tools. This gives in some detail the methods of manufacture of rail bonds, and also some carefully prepared information on their selection. Tables are given of the net weight in pounds per hundred bonds, and installation views of different types are shown. Rail bonding tools, such as ratchet drills, facing tools, bonding punch, bond compressor, etc., are described and illustrated, and there is also an illustrated description of the portable grinders, torches and clamps.

BOOK REVIEWS.

Handbook of Electrical Methods, compiled from the Electrical World. 285 pages; 5½x9; cloth bound. Published by McGraw-Hill Book Co., New York, and for sale by Technical Book Shop, San Francisco.' Price, $3.00.

This is a valuable compilation of practical kinks in electric construction work. The text is divided into ten chapters treating of underground work, overhead construction, meters, switchboards, circuits, switches, transformers, interior wiring and motors. Each chapter gives a large number of methods of accomplishing work met in actual practice. These are arranged from articles published in the Electrical World during the past three years and is a veritable mine of suggestions for the installer and operator.

Electric Arc Phenomena. By Ewald Basch; translated from the German by K. Tornberg, General Electric Company; 194 pp.; 6x8½ in.; cloth bound. Published by D. Van Nostrand Company and for sale by Technical Book Shop, Rialto Building, San Francisco. Price $2.

This book discusses the subject thoroughly. The author considers that it is of paramount importance to separate the essential from the non-essential facts regarding electric arc phenomena and to assist the student as well as the practicing engineer in those mental operations and elements of knowledge which involve fundamental principles, the mastering of which is indispensable for an understanding of the present state of the art as well as for the stimulation of independent practical work of a progressive kind. To this end there are chapters on Electric Arc Phenomena; The Typical Carbon Arc; Electrode Materials and Their Physical Properties; The Theory of Electrical Discharges Through Gases; Spark Discharges; Voltage, Current Conditions; Distribution of Energy in the Arc; and Efficiency of Commercicial Types.

INDUSTRIAL

EXCEPTIONAL EXPANSION BEND.

The accompanying illustration shows a 10 in. expansion bend containing 30 ft. of full weight pipe, with Pittsburg flanged joint, recently installed in Bakersfield No. 3 Station

Expansion Bend Containing 30 ft. Pipe.

of the San Joaquin Light & Power Corporation. It will be noted that there is no joint at the top. This rather remarkable equipment was supplied by the Pittsburg Piping & Equipment Company.

EXHIBIT OF WIRING DEVICES.

The illustration below is a reproduction of the Sample Cabinet recently installed by the Bryant Electric Company in their offices at 149 New Montgomery street, San Francisco. This cabinet contains a complete line of the latest wiring devices to be put on the market, including all types of sockets, switches, cutouts, fuses, rosettes, heating control devices, etc. A thorough inspection of this exhibit will convince one that the highest standard of quality, workmanship and convenience has been reached by the Bryant Company in the manufacture of their product. A cordial invitation is extended to all jobbers, architects, contractors, fixture manufacturers, in fact to all who may be interested in electrical wiring devices, to inspect this interesting exhibit.

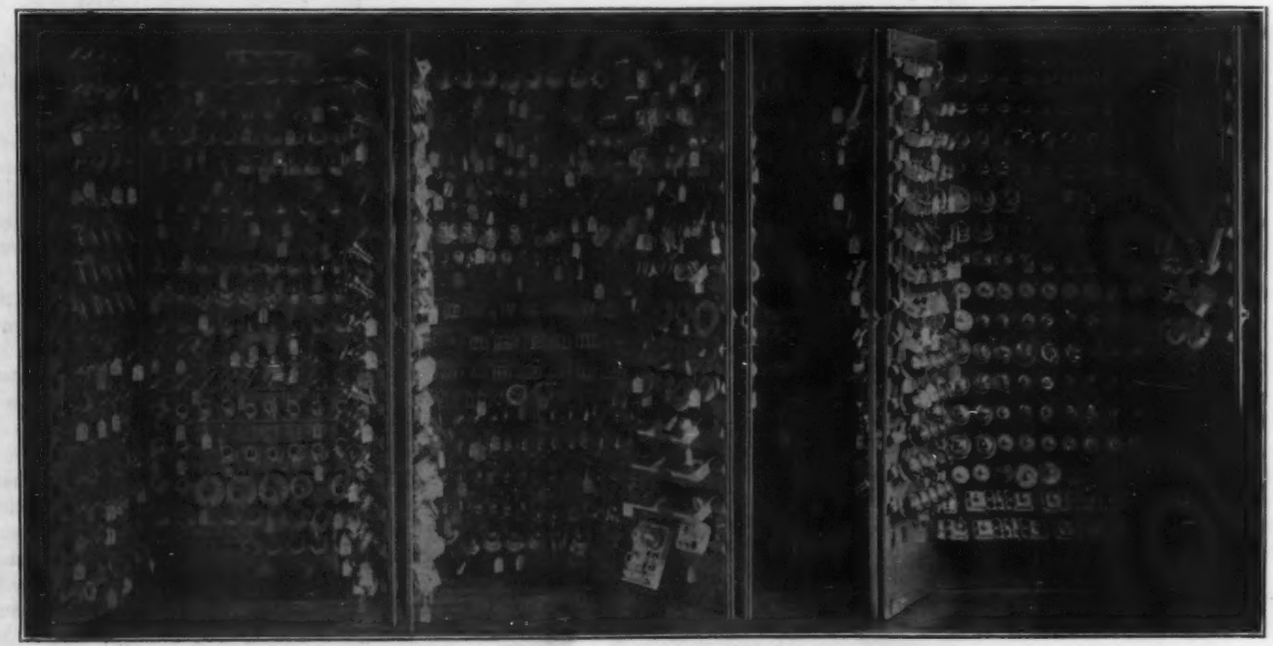
TELEPHONE REPEATING COILS.

Ever since the first idea of electrical communication over wires, either by dot and dash or direct conversation, was put into practice, heroic efforts have been made by the inventive minds to perfect as far as possible, all phases of electrical apparatus. The result is that evolution has played its part to a point almost beyond belief, and obstacles thought unsurmountable have been gradually overcome.

Telegraphing, when finally adopted as a method of communicating over distances, short and long, was found to be simple to a degree, compared with the wonder of it but, early in its commercial success, the telegraph companies were faced by the necessity of adopting some method of construction by which a single wire could be utilized for the transmission of a number of messages simultaneously. Undaunted however, the scientific and inventive brain of the day took issue with the problem, fully realizing that the extremely high cost of long lines for single messages would, in consequence, compel a correspondingly high rate for transmission, thus placing telegraphic communication so far within the pale of luxury that it could not be utilized nor considered by the masses. It is volume which spells success to every business and as the telegraph companies must likewise depend upon volume, every encouragement was given the inventor with the result that the duplex and quadruplex systems, used today in telegraph operation are the crowning achievement of those scientific delvers.

Telephony, with its maze of apparatus, at once secured a firm foothold in the world commercial and social, becoming the right hand of the business man in his office and a servant in his home—a boon, in fact, upon which he became wholly dependent. For long, his country cousin was denied all this, but now, we find the vast stretches of our farming country punctuated at nearly all necessary points by telephone companies in a large measure prepared for first class local service with constant demand for more extended service. The majority of these companies are confronted by the necessity of providing longer lines.

The construction of long toll lines, has, in the past, been more or less prohibitory owing to the necessary outlay,



Bryant Electric Company's Sample Cabinet.

coupled with the fact that all available capital was required to construct the shorter local lines between the several exchanges as they were established and the outcome of this growth is an extensive system of pole lines carrying numerous short local circuits. Thus, the necessity frequently arises of building up a circuit through a half dozen switchboards in order to reach points a short distance away, by comparison, resulting in poor transmission, annoying interruptions from operators coming in on the line for supervision and, withal, slow service.

Telephone companies that owe their inception to a local desire or demand for neighborhood communication, now find themselves obliged to cope with an ever-growing demand for good commercial service between constantly increasing distant points of their systems, which means that they must equip their lines with a system whereby more than one message may be transmitted over a single line at the same time or be prepared to shoulder the great expense necessary in the construction of long toll trunks.

Fig. 1.

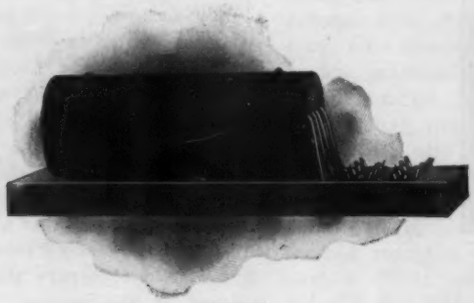


Fig. 2.

Fig. 3.

Fig. 4.

Fig. 5.

As a matter of fact, the same problem which confronted the telegraph companies, faces the Independent telephone companies today, but fortunately for them, the manufacturer, abreast of the moment, is prepared to assist them at a comparatively nominal cost, and at once obviating the large expense of extensive re-construction and making for the desired betterment of service.

It is hardly necessary to say that the telephone manufacturer realized early in the day, the coming necessity of a multiplex system which would permit the successful working of telephone circuits. Innumerable attempts to solve the problems were made, but with indifferent success accompanied with many absolute failures until the nut was cracked by the development of a repeating coil affording high efficiency and perfect electrical balance together with the elimination of cross talk between the several lines by a systematic arrangement of transposition of the engaged physical circuits.

Fully alive to these conditions the Kellogg Switchboard & Supply Company offers various types of repeating coils designed especially to meet the requirements of every class of telephone service. In magnetic switchboards in which two clearing-out drops are used in the cord circuits, repeating coils, whenever used, must be constructed so as to prevent ringing current from passing inductively from one winding to another, while the high frequency voice currents must pass with only slight loss. These requirements are fully met by their No. 8-A repeating coil shown in Fig. 1.

For another class of service, a repeating coil which will allow both voice currents and ringing currents to pass, is required. Such a repeating coil is used in cord circuits of magneto switchboards, having single clearing-out drops, as well as in phantom telephone circuits, and under similar conditions. For this purpose, they manufacture three different styles of repeating coils, the No. 9-A, shown in Fig. 2, the No. 13-A, in Fig. 3, and No. 14-A, in Fig. 4.

No. 9-A, which is less expensive than the other two, is suitable for use in connection with short lines of low resistance. The No. 13-A was designed especially for phantom and long distance work, and is said to be the most efficient ring-through and talk-through coil which has ever been developed. It is enclosed in an iron case, which excludes moisture and prevents cross talk. It consists of four windings each of which is wound separately so that if one is burnt out by lightning, or high tension current, it can be replaced at small expense, thus making it unnecessary to throw away the entire coil.

The No. 14-A repeating coil is the same as the No. 13-A, aside from the fact that the iron shell is omitted and, as a result, it must be mounted inside of a building where it is not exposed to the elements.

The Kellogg Company has recently placed upon the market their No. 15-A repeating coil, illustrated in Fig. 5. This is primarily a talk-through coil but so compact that it can be mounted in a very small space. No. 15-A represents their very latest development in repeating coil construction. It was especially designed for long distance work, or for any condition in which a high efficiency talk-through coil is desired.

NEWS NOTES

INCORPORATIONS.

LONG BEACH, CAL.—Towne-Lantz Electric Company; $15,000, subscribed $12,000, by A. A. Towne, F. O. Lantz et al.

ILLUMINATION.

SUMAS, WASH.—Plans for rebuilding the lines of the Sumas Electric Company in this city have been submitted to the public service commission.

EUGENE, ORE.—The council has passed an ordinance for the establishment of ornamental street lighting on Olive street, at an estimated cost of $1920.

SAN RAFAEL, CAL.—The city attorney was directed to prepare resolution of intention for installinf electroliers and prepare resolution of intention for installing electroliers and

LOS ANGELES, CAL.—Sealed bids will be received up to February 2d by the board of supervisors of Los Angeles county for installing and maintaining a system of street lighting in Ivywild lighting district.

HUNTINGTON BEACH, CAL.—The city trustees have granted the Pacific Light & Power Company a 40-year franchice for supplying light and power to Huntington Beach, the present supplying company, the Huntington Beach Company, turning over poles and wires to the Pacific Company.

HUGHSON, CAL.—At the last meeting of the board of trade the matter of street lighting was taken up, and a committee consisting of Miles Shelly, E. F. Sawdey, and C. P. Richardson was appointed to prepare a plan with the idea of lighting the entire town in a creditable manner.

SEAL BEACH, CAL.—Application has been filed for laying of gas mains throughout the town of Seal Beach, and it is expected that immediate action will be taken. The main lines are already to Almitos, and soon as the application is granted work will begin on the extension to this resort.

CALEXICO, CAL.—The city trustees are figuring upon the possibility of Calexico operating its own electric light plant. The city engineer has been instructed to estimate the cost of installing and operating a plant in conjunction with water works which will be capable of furnishing lights for the streets.

CONCORD, CAL.—The town trustees have awarded to S. Waldo Coleman a franchise to serve this city with gas for the next fifty years. Coleman, who is organizing the Contra Costa Gas, Light & Heat Company, was the only bidder for the franchise and will at once build a gas plant and service mains to supply Martinez, Concord, Pittsburg and Antioch.

OGDEN, UTAH.—The General Service Corporation, represented by J. H. Bacon, has petitioned the Ogden City Commission to extend the time limit of the franchise granted to C. A. Boyd from February 14, 1914, to January 1, 1915. The communication states that a deal is pending whereby this corporation is to purchase the Ogden gas plant of the Utah Light & Railway Company. Officials of the latter company, however, deny that any such sale is under consideration.

SALT LAKE CITY, UTAH.—The board of education has decided to enter into a contract with the Utah Light & Railway Company for the purchase of electricity for supplying the new East Side High School. They have abandoned their original intention to install a generating plant for the purpose of supplying electric service, a careful investigation having demonstrated the fact that central station service is cheaper. The domestic science department of the high school will be equipped with electric hot plates, and all cooking in the cafeteria will be done by electricity.

TRANSMISSION.

EDMONTON, ALTA.—The estimated expenditure for the year 1914 in the city of Edmonton includes $500,000 on extensions to the electric power plant. A new power house will probably be built and one or more units installed.

KLAMATH FALLS, ORE.—Engineer McLane has been instructed to place a physical valuation on the Ankeny ditch, the power site at the head of the ditch and 5000 miners' inches of water. This is another step toward municipal power and light.

CLIFTON, ARIZ.—The Detroit Copper Mining Company has begun work on an electric line leading from Morenci to the company's mining properties in the vicinity of Metcalf, known as New England group. Power will be used for extraction of ores at the company's property.

STOCKTON, CAL.—A contract has been closed by the Western States Gas & Electric Company with the California Exploration Company covering 1075 h.p. At the present time this concern is using 240 h.p. served by the Western States Company and the new load will be taken on about June 1st

BREMERTON, WASH.—The council passed an ordinance authorizing the promoters represented by Gustavus F. Rust, to build a power plant on Hamma Hamma River near Elder in Mason county, and to transmit the power to Bremerton, and build a street railway system. An election will be held April 14 to ratify the measure.

HOOD RIVER, ORE.—With 40 members present the Odell Development League met and by unanimous vote took action toward the construction of a co-operative light and power plant on the Hood River near the vicinity. A thorough investigation will be made by a committee composed of Mark Cameron, Geo. Sheppard, Harry Connoway, R. E. Miller and J. E. Ferguson, to secure the sentiment as to stock subscriptions and to secure the services of a hydraulic engineer, who will make estimates as to the cost of the construction on different power sites controlled by the members of the league.

TRANSPORTATION.

STOCKTON, CAL.—The Stockton Electric Railroad Company has filed with the board of supervisors an application for a 50-year franchise for a street car line to be extended out El Dorado street to Castle, in north Stockton.

BANKS, ORE.—There is a rumor that the United Railways Company's electric line will be built into Banks soon from its present terminus, a mile southeast of town. Passenger Agent Powers and L. G. Selfredge were in town gathering data to be placed before the company when considering the proposed extension.

SAN FRANCISCO, CAL.—The Pacific Gas & Electric Company, from which the city purchases power for the Geary street railroad, has been notified by the board of public works, to prepare to furnish additional power for the extensions of the city's system. This power will be needed, the city engineer explains, on August 1st, for the Van Ness avenue and Chestnut street extensions; September 1st for the Potrero avenue line; September 15th for the Fort Mason extension, October 1st, for the Columbus avenue line; November 1st for Stockton street; December 1st for California street and on January 1, 1915, for the Church street extension.

SAN FRANCISCO, CAL.—The public utilities committee of the supervisors again has under consideration the proposition of making the property owners pay the entire cost

of paving unaccepted streets on which the Municipal Railway lines will run. Last year the committee favored this scheme, but on account of the change in the board's membership it is to be discussed again. It is admitted by the supervisors who support this proposal that if a private corporation were to build a railway on unaccepted streets it would have to pave between and on the sides of the tracks, but they think that the city should be exempt from this requirement. The question is to be talked over at the committee's meeting next week.

STOCKTON, CAL.—In the office of the county recorder last week was recorded the deed of the San Joaquin Valley Electric Railroad wherein all company property is conveyed to M. McCormick Company, which has taken over all the interests of the corporation to protect its end, following the recent foreclosure, and in order that money invested by it may not be lost. The Mercantile Trust Company of San Francisco, holders of the road's bonds, sold the property to Paul McDonald, a capitalist interested in the trust company, when the railroad defaulted in certain payments, and McDonald has turned the property over to the McCormicks. Whether T. K. Beard, the Modesto contractor, who controls the Modesto & Empire Railroad, will do anything toward recuperating the running stock is a matter of conjecture.

VANCOUVER, B. C.—The annual report of the B. C. Electric Railway Company to June, 1913, reflects to some extent the trade conditions in that province. The gross earnings increased $1,035,869, or about 17 per cent, but practically the whole amount was absorbed by higher working expenses, due in part to the coal strike. These expensive working conditions are said to still continue and may affect the current year's earnings. The directors hope, however, to maintain the present rate of dividend by the recently announced increase in the fares and by reducing expenses wherever possible. The total money expended up to June 30, 1913, by the company, amounts to $45,168,312. The amount paid out in interest and dividends for the year totalled $1,888,139, equal to 4.18 per cent on the entire investment. In the past financial year the number of passengers carried was 71,973,822, an increase of 1,819,656. In the first year of operation, 1906, 12,395,582 passengers were carried.

SAN FRANCISCO, CAL.—J. K. Moffitt, chairman, United Properties Company trustees, and Frank B. Anderson, chairman, F. M. Smith advisory committee, issued a statement late Saturday confirming the completion of legal formalities whereby they have sold to George G. Moore and associates the control of the San Francisco-Oakland Terminal Railways. Mr. Moore will immediately take over the control, management and operation of these railways. "The settlement of the transbay railroad situation," the statement explains, "is coincident with an arrangement whereby Mr. Moore and his associates undertake the refinancing, development and advancement of the United Light & Power Company and the Union Water Company as soon as these corporations can be segregated and detached from the United Properties Company of California. This settlement disposes of all disputes existing among the three principles who consolidated these properties." John Drum, secretary of the Smith advisory committee, which has been administering the affairs of F. M. Smith for the benefit of his creditors, stated that besides settling the disputes between Hanford and Tevis and Smith, and the lawsuits filed by Hanford and his associates the agreement is of great advantage to the Smith creditors, because it will provide funds for the settlement of due obligations, provide for necessary development work, and the stock so sold, as payments thereon are made, will liquidate the indebtedness and tend to give a fixed valuation to the stock still remaining in the hands of Smith's creditors. The sale is contingent upon the extension of the $2,500,000 Halsey notes to September 12, 1914, and of the Key Route basin notes to November 20, and is of course subject to the approval of the state railroad commission.

TELEPHONE AND TELEGRAPH.

EDMONTON, ALTA.—Considerable expenditure will be made in the electric light and telephone departments, though this will not be quite as heavy as in 1913.

CENTRALIA, WASH.—The South Hannaford Telephone Company has applied for a franchise and authority to construct, maintain and operate telephone lines over certain county roads.

SAN FRANCISCO, CAL.—City Attorney Long has revived his recommendation for negotiations with the Pacific Telephone & Telegraph Company for the payment to the city annually of a percentage of its gross receipts as a compromise of the litigation over its absorption of the Home Telephone Company.

VERNON, B. C.—The Vernon Board of Trade has petitioned the provincial government for assistance in laying a telephone cable in Lake Okanagan to serve the district on the west side of the lake. The petition states that there would not be sufficient subscribers to justify the local company in making the outlay but that the company would undertake to buy back the cable as soon as that part of the system becomes self-sustaining.

WATERWORKS.

UNION, ORE.—The city officials are working out the problems of a charter for the city of Cove with a view to installing a new municipal water system.

EL MONTE, CAL.—Citizens of El Monte have voted on the matter of issuing bonds in the sum of $36,250 for the purpose of the construction of a municipal water system.

AVALON, CAL.—The Board of Trustees have accepted plans of the city engineer for a $68,000 water system and has ordered them submitted to the Banning Company for approval.

MANHATTAN BEACH, CAL.—Bids for construction of a municipal water system will be opened at the next meeting of the board of trustees. The improvement will cost more than $80,000.

ESCONDIDO, CAL.—The city trustees have purchased an acre and a half of ground as a site for a pumping station of the new city water system that is to be installed at a cost of $100,000 as soon as a market is found for the bonds.

BAKER, ORE.—Bonds in the sum of $44,000 were recently voted here. The proceeds will be used in the construction of the water system. The work to be done is the laying of 8000 ft. of cast iron pipe from the reservoir to South Baker. The sizes of the pipe to be laid will be 12 and 16 in.

OREGON CITY, ORE.—A resolution asking the city council of West Linn to make a formal offer to the Pure Water League of Oregon City to buy water from Oregon City in case that city built its line to the south fork of the Clackamas, has been passed by the West Side Improvement Club.

SAN DIEGO, CAL.—To issue $705,000 bonds recently voted for the improvement of the water system in denominations of $500 and $1000, is the plan of City Attorney Cosgrove, City Treasurer Stewart and Councilman Fay, who are now making the necessary arrangements. The city will first purchase the entire issue at par, then reoffer them for sale.

CALGARY, ALTA.—Water Engineer A. W. Ellison Fawkes gives the cost of a waterworks system in four different estimates, on constructing gravity lines to different sites for storage dams 39, 38, 36 and 32 miles from the city, with the following respective costs: $2,159,673 for the 39 mile; $2,128,763 for the 38 mile; $1,977,322 for the 36 mile, and $1,718,343 for the 32 mile. The alternate scheme of pumping water from the Bow River with a big filtration plant, Mr. Fawkes estimates, would cost $1,119,835 for a 40,000,000 gallon supply and $807,657 for a 20,000,000 gallon supply.